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Antifouling Coating for Topside Equipment

A presentation of a coating technology for the prevention of crude oil derived fouling

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Outline

- Introduction to Sol-Gel technology
- Coating of Plate Heat Exchangers for Crude Oil
- Pilot Plant Coating Facility
- Status of today

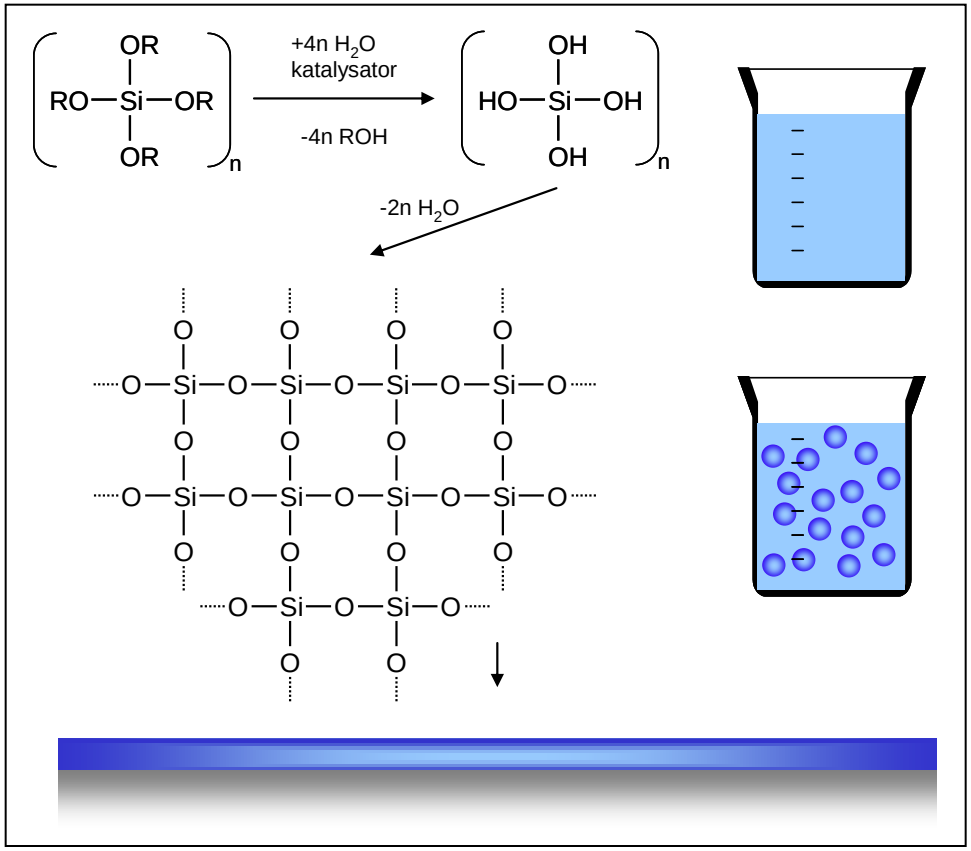
The Sol-Gel process

What is the Sol-Gel process?

The term Sol-Gel describes a technology for the synthesis of glass ceramic coatings from liquid reagents.

Traditional Glass ceramics:
Solid components are sintered at a very high T to obtain fully inorganic glass ceramic coatings. High strength, poor flexibility, no 'specialized' functions.

Sol-Gel technology:
Liquid reagents form at glass ceramic coating. Cures at low T. Less hard, but more flexible than traditional. Possible to obtain coatings with highly specialized physical/chemical properties.



The Sol-Gel term

Why is it called Sol-Gel?

The Sol-Gel technology is founded on colloidal chemistry.

Colloids are ‘stable systems, where one material is evenly distributed in another material’

Media/Phase		The disperged phase (“the solubilized")		
		Gas	**Liquid**	**Solid**
The continuous phase (”the solvent")	**Gas**	None (All gasses can be mixed)	Liquid aerosols (fog, spray, etc.)	Solid aerosols (smoke, clods, etc.)
	Liquid	Foam (whipped cream, etc.)	Emulsion (milk, mayonnaise, etc.)	Sol (ink, blood, etc.)
	Solid	Solid Foam (PUR, styrofoam, aerogel,…)	Gel (agar, gelatin, gelé, etc.)	Cured Sol (ruby glass)

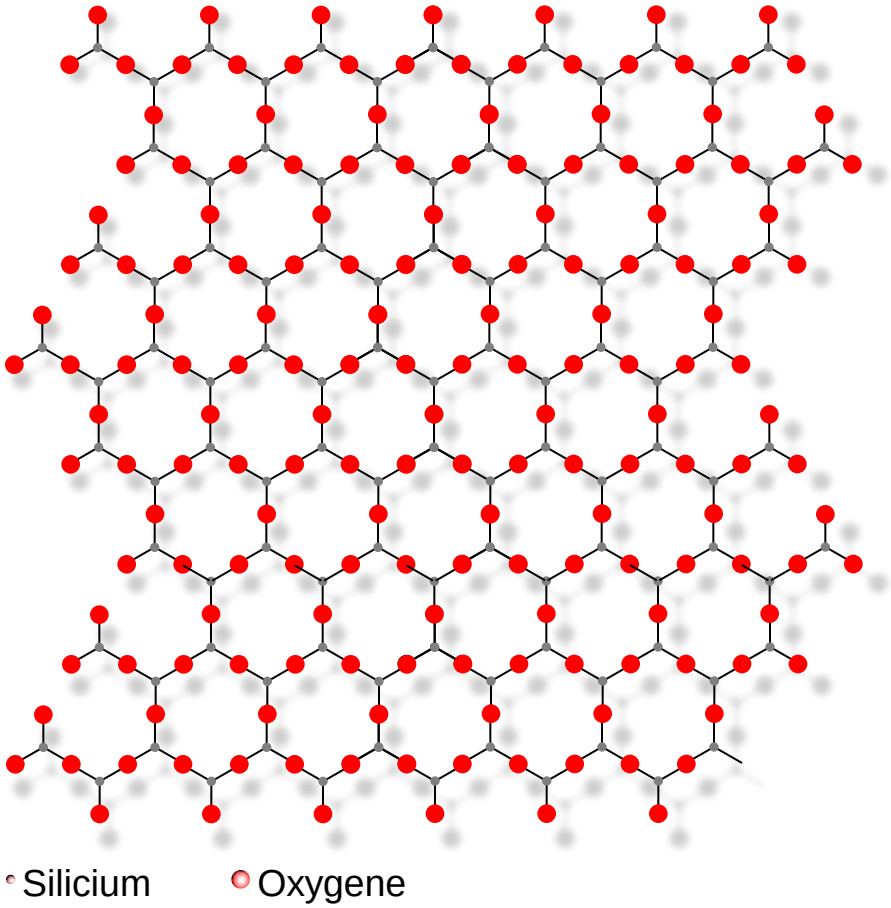
The Sol-Gel term is derived from the fact that the two colloidal steps are present in the formation of glass ceramic coatings formed from this particular process.

Introduction to the Sol-Gel technology

Quartz and crystal glass are primarily made up of Si and O atoms arranged in a perfect crystalline structure.

÷ Sol-Gel technology

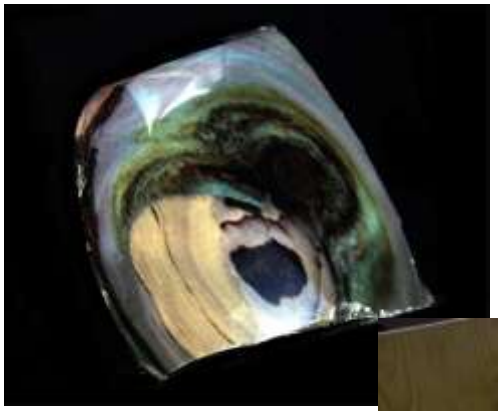
Naturally occurring quartz crystal



Introduction to the Sol-Gel technology

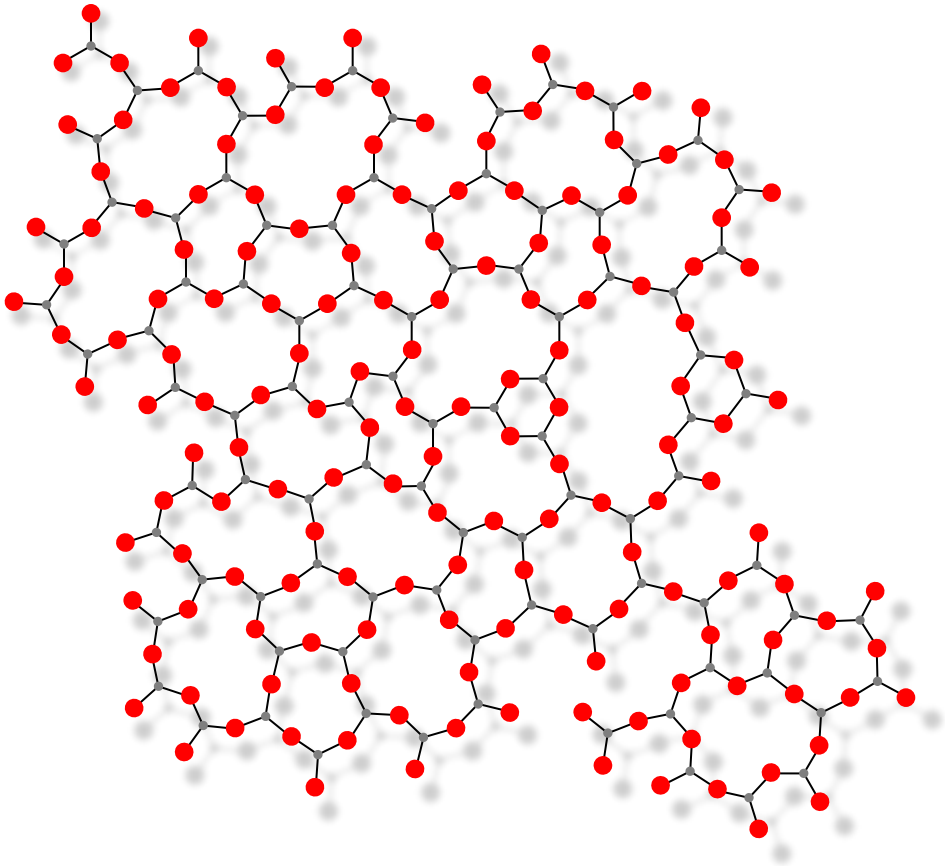
Amorphous glass
- Inorganic
- Contains eg. sodiumcarbonate
- Ordinary glass (window panes, etc)

Can be produced by a Sol-Gel process
- Superior optical properties
- Brittle
- Telescope lenses



Obsidian: Naturally occurring amorphous glass

Coated telescope lens

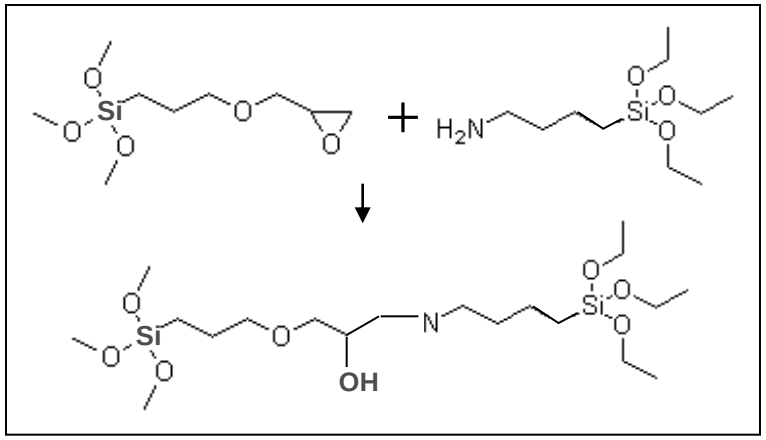


Silicium Oxygene

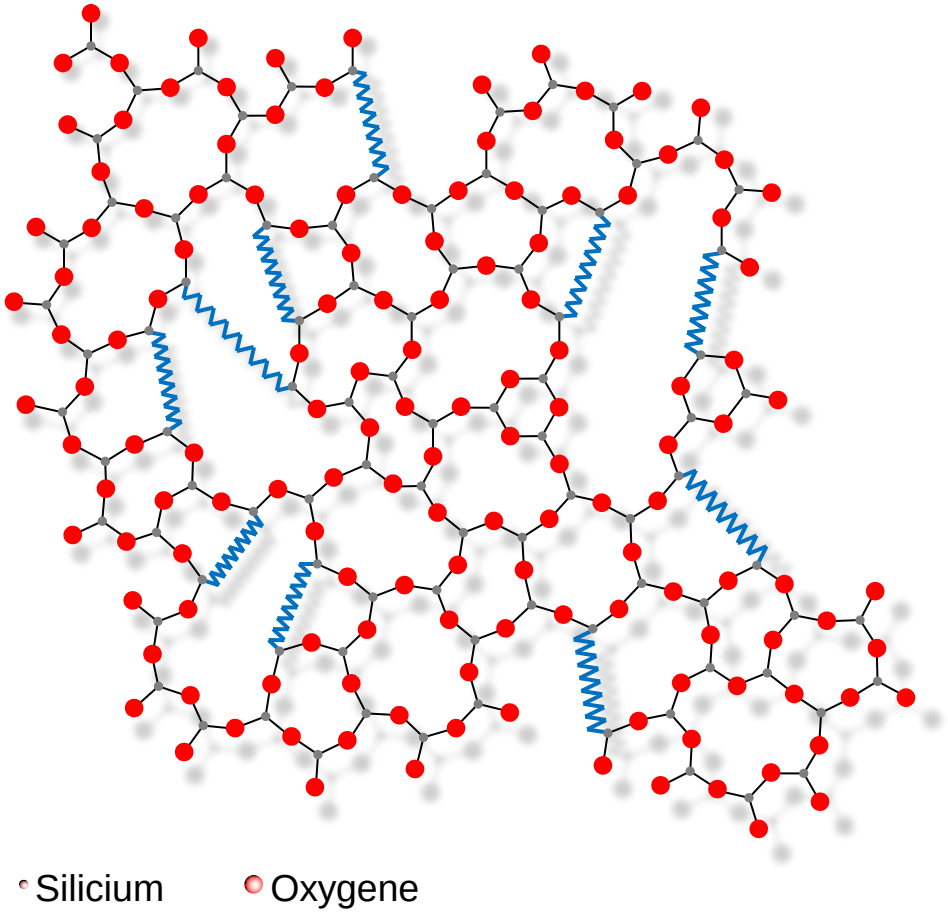
Introduction to the Sol-Gel technology

Hybrid Sol-Gel glass ceramics
- Amorphous
- Organic and inorganic

Organic component = functionality, e.g.:
- Easy-release
- Hydrophobic/hydrophilic
- Anti-graffiti
- Flexibility



Reaction between Epoxy og Amine



Introduction to the Sol-Gel technology

General characteristics of the Sol-Gel based glass ceramic coatings:

- Thin (3-15 µm)
- Transparent
- Flexible
- Good adhesion to different materials

Four ‘handles’ for the formulation of Sol-Gel coatings:

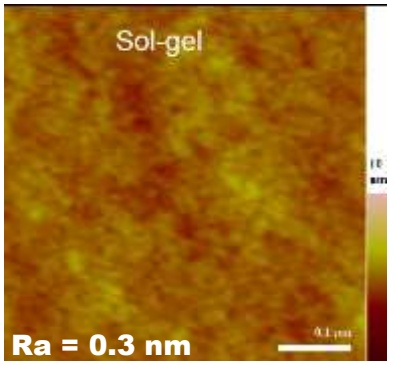
- The in-organic, glass-ceramic matrix
- Surfactant, additives
- ‘Organic modified silanes’ – ORMOSILS
- Solid fillers

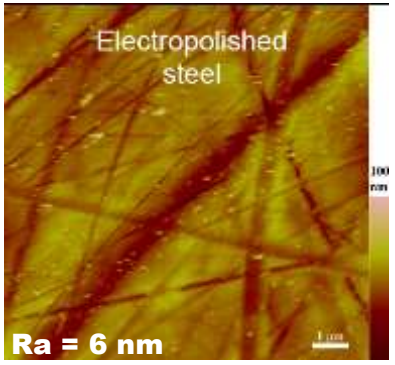
Enables the development of coatings with customized features:

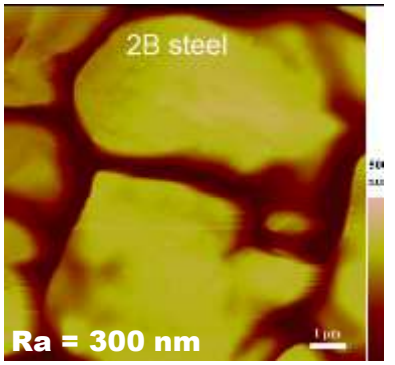
- Repellent
- Low surface energy
- Smooth

Application:

- Spray, dipping, spinning, etc.
- Curing at 200 °C







Research and Development of Crude Oil Repellent Coating

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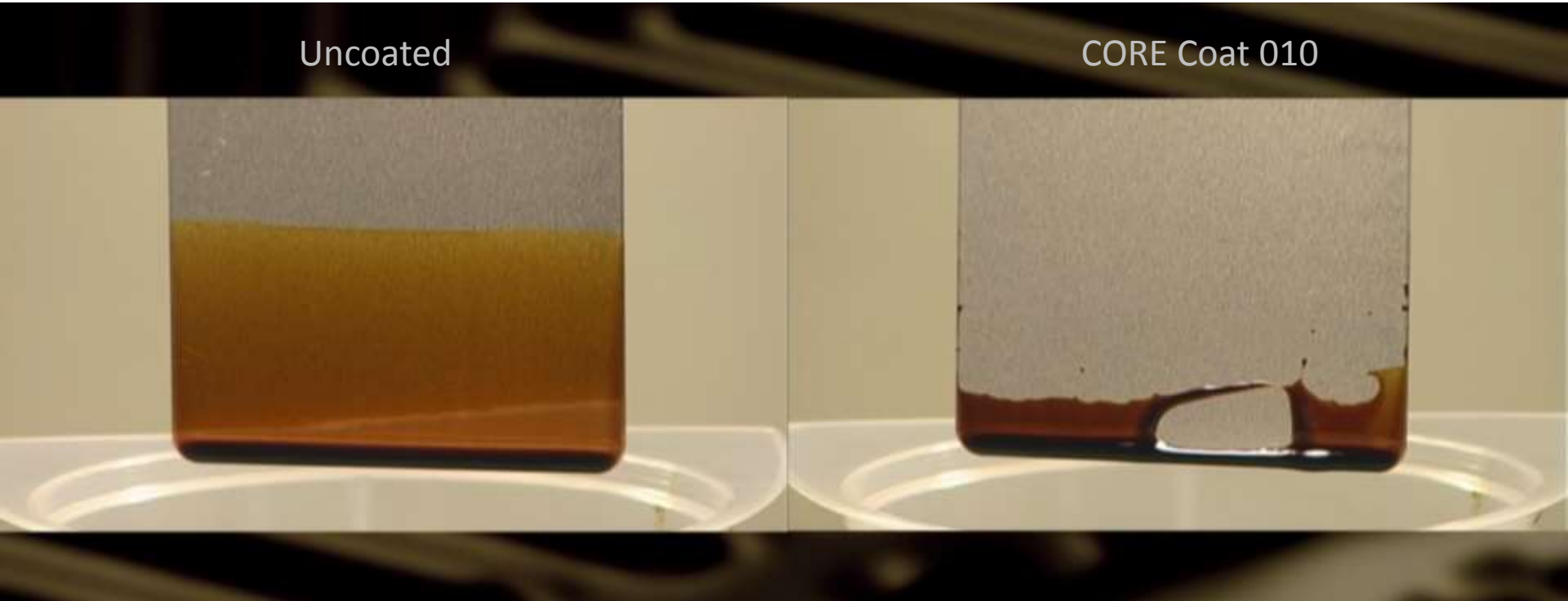
CORE Coat 010 was adapted and lab-tested under relevant parameters

Extract from test regiment

- Stability to crude oil (RT and 50 °C)
- Adhesion to ss, Ti og Al
- 1000 hr Salt spray testing, Atlas Cell testing
- Flexibility
- Heat Conductivity (reduction of PHE efficiency)
- Contact point wear



Crude Oil Repellent Coating Offshore Tests 2009

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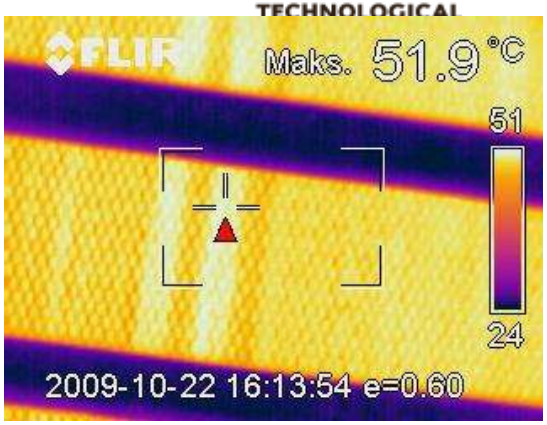
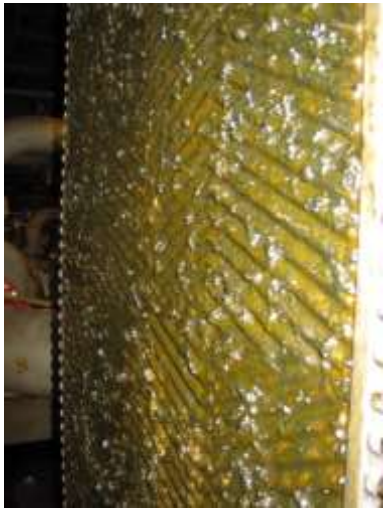
Based on laboratory tests, the two best performing coating systems were chosen for preliminary offshore tests on 30 Alfa Laval M20 plates:

15 x CORE Coat 010
15 x CORE Coat 020

- Operational for seven months in the North Sea
- Surveillance by thermographic camera and laser thermometry
- Disassembly and inspection





Crude Oil Repellent Coating Offshore use

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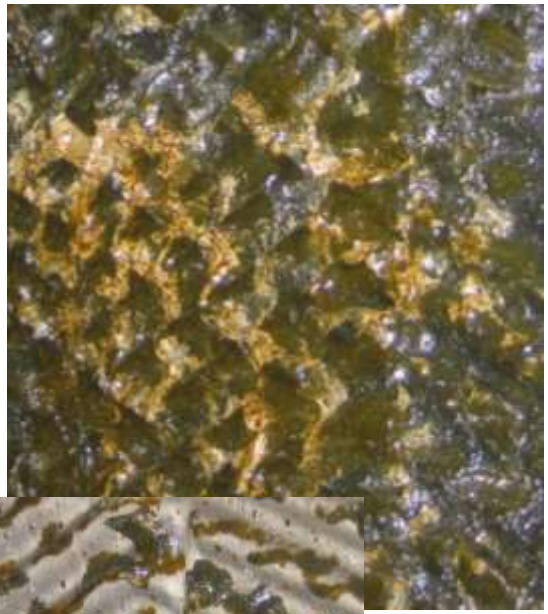
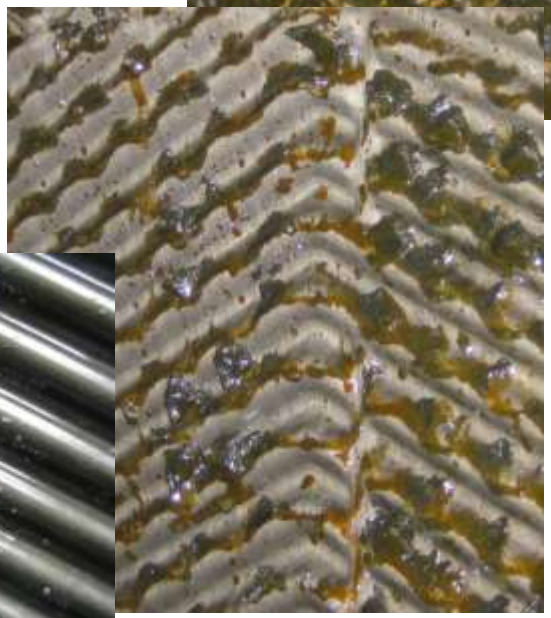
Inspection of PHE plates after 7 months of operation

- CORE Coat 010 og 020 provide superior repellent properties towards both organic and inorganic fouling
- CORE Coat 010 exhibits the superior adhesion and integrity
- CORE Coat 020 exhibits slightly inferior properties compared to CORE Coat 010

Since, thousands of plates have been coated with CORE Coat 010 and excellent data have been retrieved.

- Efficiently repels crude oil fouling (organic and inorganic components) – approx. 1000 days offshore
- Is stable in contact with crude oil
- Has proven effect on Ti PHE units for crude oil cooling





Status Today

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CORE Coat 010 (Crude Oil Repellent Coating 010):

- **Pilot production facility established in 2010**
- **Flexible production – permits new coatings assignments with short notice**
- **Cooperation with Alfa Laval on PHE application**
- **Coating of new and old plates possible**
- **ISO9001 certifiability in process**

Status Today

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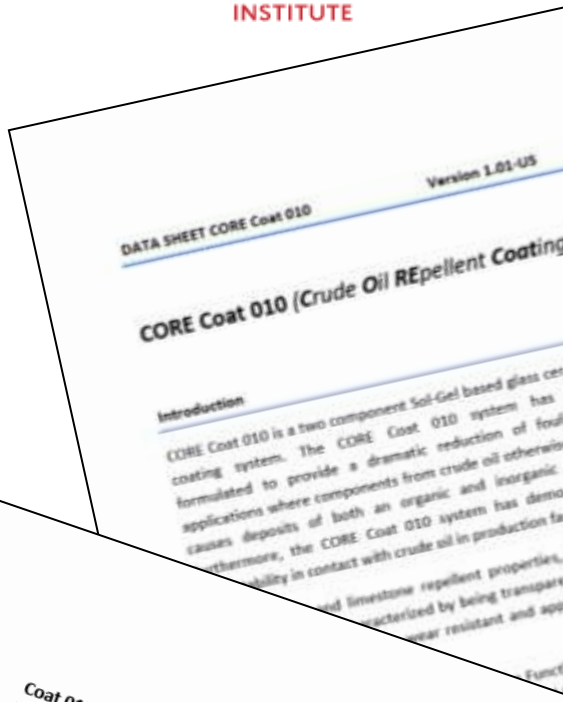
CORE Coat 010 (Crude Oil Repellent Coating 010):

Focus on environmental impact

- **ISO14001 certifiability in process**

- **Documentation available on**
  - **Environmental Impact**
  - **HSE**

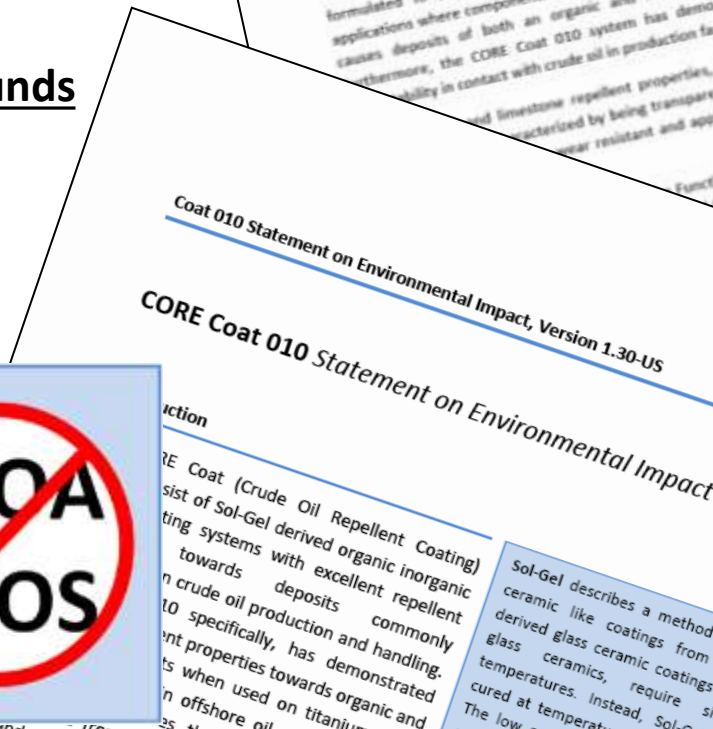
- **CORE Coat 010 is not formulated from nano-particles**
- **CORE Coat 010 does not contain any fluorated compounds**


DATA SHEET CORE Coat 010 Version 1.01-US

CORE Coat 010 (Crude Oil REpellent Coating

Introduction

CORE Coat 010 is a two component Sol-Gel based glass ce
coating system. The CORE Coat 010 system has
formulated to provide a dramatic reduction of fou
applications where components from crude oil otherwis
causes deposits of both an organic and inorganic
Furthermore, the CORE Coat 010 system has demo
durability in contact with crude oil in production fa
and limestone repellent properties,
characterized by being transpare
wear resistant and ap


Coat 010 Statement on Environmental Impact, Version 1.30-US

CORE Coat 010 Statement on Environmental Impact

uction

RE Coat (Crude Oil Repellent Coating)
sist of Sol-Gel derived organic inorganic
ting systems with excellent repellent
towards deposits commonly
n crude oil production and handling.
10 specifically, has demonstrated
nt properties towards organic and
ts when used on titaniu
n offshore oil

Sol-Gel describes a method
ceramic like coatings from
derived glass ceramic coatings
glass ceramics, require
temperatures. Instead, Sol-G
cured at temperat
The low

CORE Coat 010 IS NOT a 'NANO COATING'

CORE Coat 010 is a Sol-Gel derived hybrid coating. In the process of synthesizing the coating, no nano-particles are added, nor any other nano-materials (e.g. nano-flakes, nano-tubes, nano-sheets, etc.). The coating does therefore not constitute any hazard derived from the presence of added nano-materials, why the coating can be handled with the same care and diligence that any coated material
coating will give rise to frag

CORE Coat 010 does NOT contain FLUORATED COMPOUNDS

No PFOS, PFOA or any other kind of per-fluorated or poly-fluorated compounds are present in the CORE Coat 010 formulation. Such substances are known to be extremely persistent in the environment. The substances are known to bioaccumulate in marine species and ultimately in polar bears and other predators at the top of the food chain. Toxicological studies on animals indicate potential developmental, reproductive and systematic effects.

The repellent properties of CORE Coat 010 rely on an entirely different technology that is documented safe, and approved for food contact.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